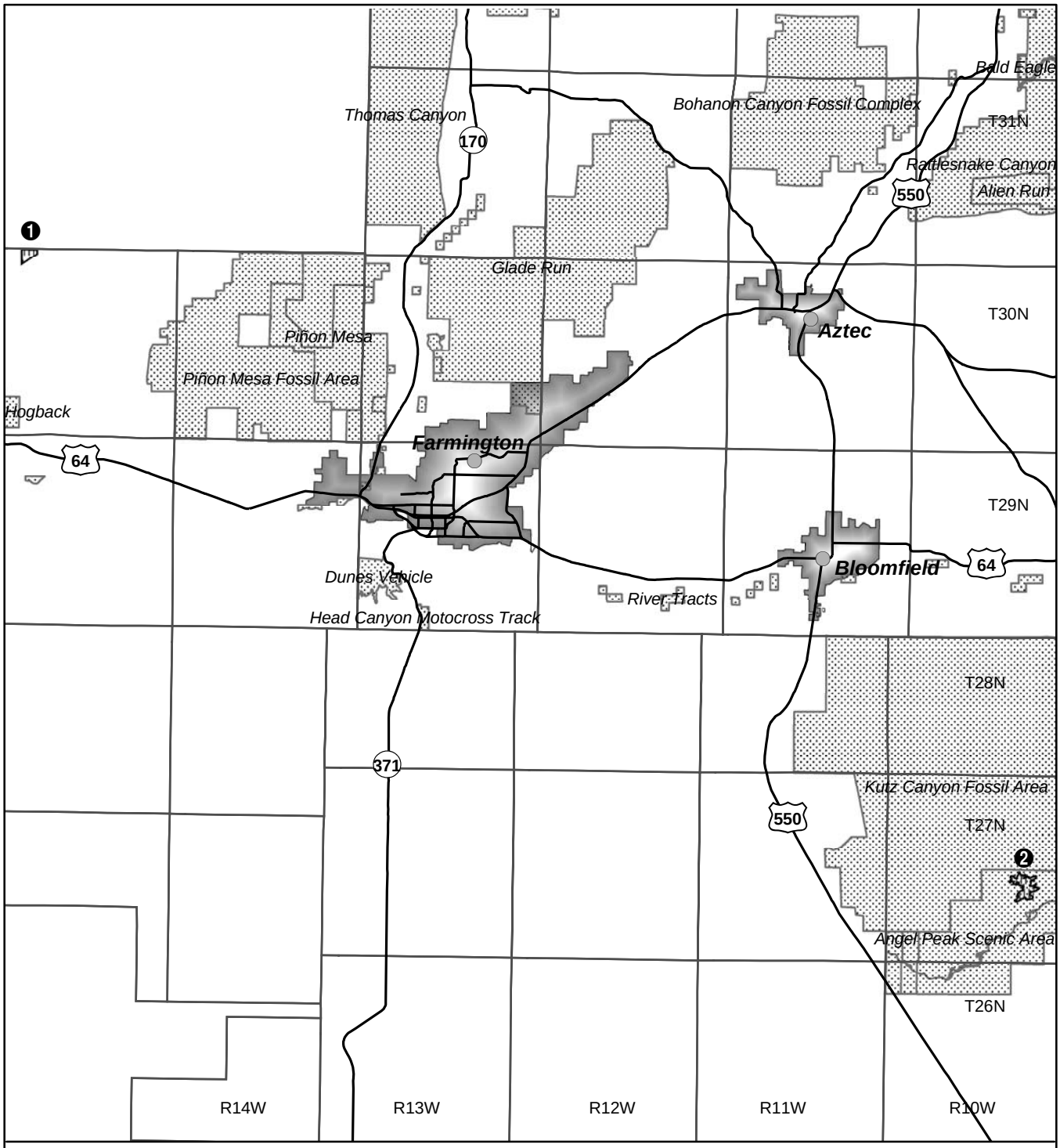
2. GEOLOGY

GENERAL DESCRIPTION

The FFO area encompasses some formations of geologic significance that are used for scientific purposes, and also contribute to the visual impact of the area. The SDAs in this section have been designated to protect two formations from damage by surface and subsurface-disturbing activities.



Map C-8: Geology SDAs

ANGEL PEAK ACEC

Site Description:

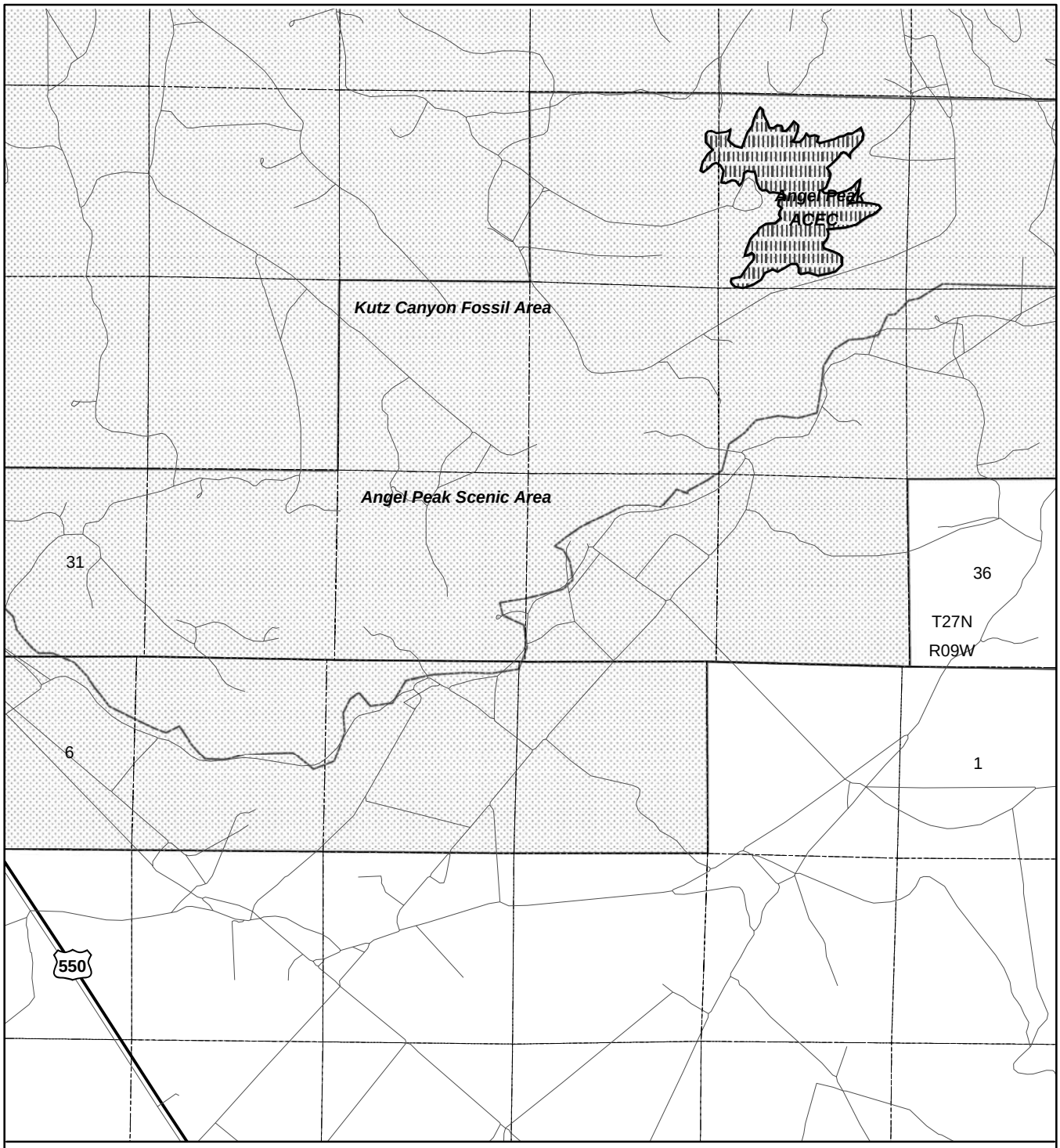
The Angel Peak ACEC (248 acres) is located within the Angel Peak Scenic Area and includes a rare geologic feature that appears as the shape of an angel with one uplifted wing. It visually dominates the area known as the Kutz Canyon Badlands and is an unusual example of extreme erosion patterns. The canyon is a barren badland of blue and gray-layered shale, carved through the centuries. The tip of Angel Peak is hard sandstone that stands alone as the land around was washed and blown away. Various other mineral deposits add reds, yellows, browns, and lavenders to the blue and gray shale strata of the canyon walls.

Management Goal:

The protection and preservation of the geologic feature and associated scenic values is the primary management goal. A secondary goal is to provide the opportunity to engage in a wide variety of recreation activities including camping, hiking, rockhounding, sightseeing, and horseback riding.

Management Prescriptions:

1. Manage existing oil and gas leases under No Surface Occupancy constraint.
2. Apply No Surface Occupancy stipulation to new oil and gas leases.
3. Maintain mining closure. Close to all other forms of mineral entry.
4. Preclude new ROWs that would negatively impact the ACEC.
5. ACEC closed to OHV use.
6. Implement VRM Class II designation. Close to all wood gathering and sales except for administrative needs with recreation staff approval.
7. Close to vegetative sales. Vegetative treatments must benefit recreation and visual experiences managed for, and be approved by recreation staff. All reclamation activity will use only native species seed/plants unless approved by recreation staff.
8. Continue current livestock grazing permitting.
9. Apply roaded natural objectives.
10. No shooting in developed recreation area.
11. Land ownership not available for disposal.



Map C-9: Angel Peak ACEC

BEECHATUDA TONGUE GEOLOGICAL FORMATION

Site Description:

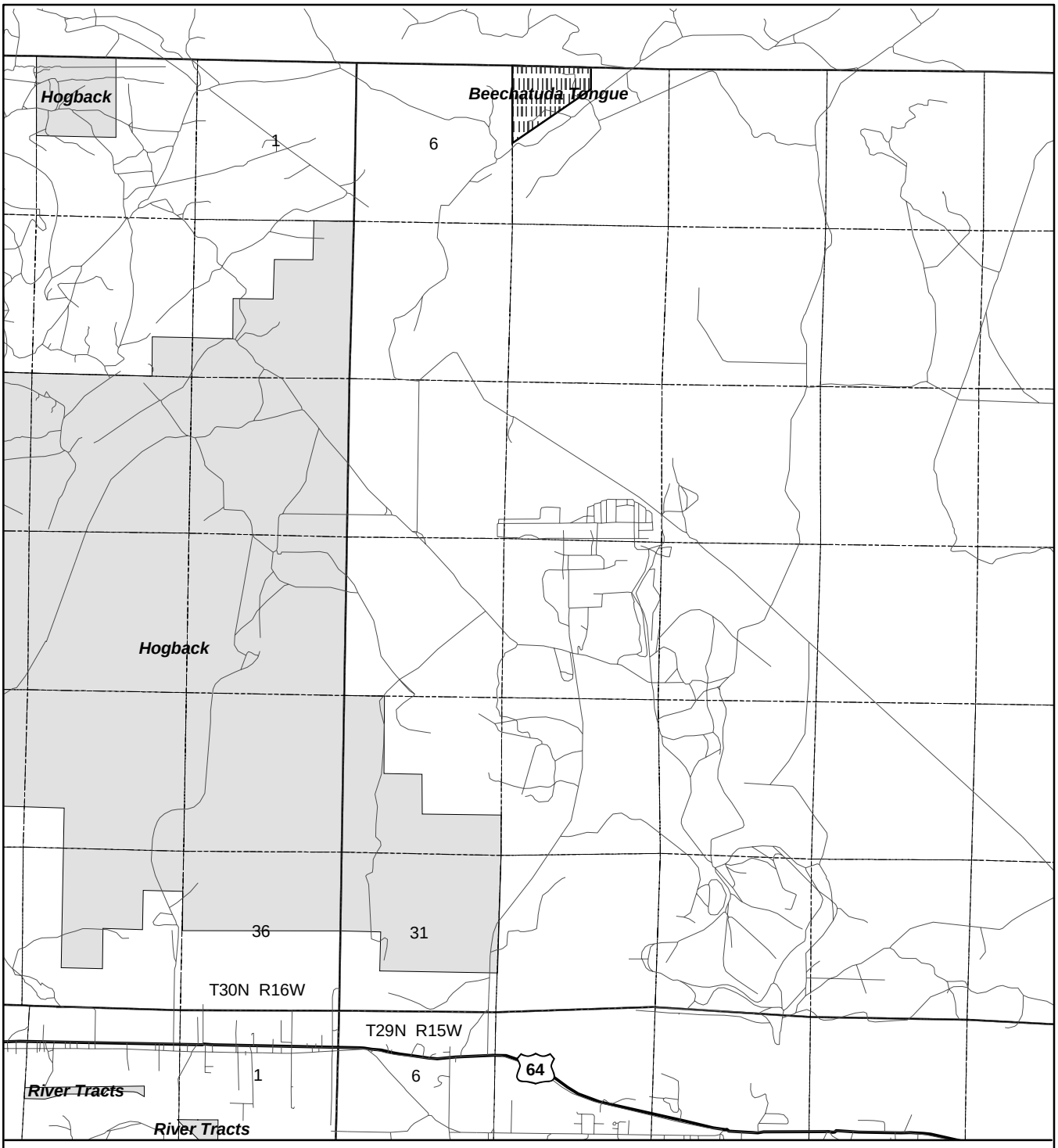
There are approximately 100 acres within the boundary of the Beechatuda Tongue Geological Formation, all of which are public land (BLM) and all of which contain federal minerals. The Beechatuda Tongue (Geology) of the Cliff House Sandstone is a rock stratigraphic unit mapped in, and named for, Beechatuda Draw in T.30N, R.15W, Section 5;NW/4. This area is the type locality for the unit. As such, it is of interest to scientists and educators as a site for comparison and study of the unit, and for possible further refinement of the stratigraphic nomenclature. It is important that the unit be preserved intact to allow these studies and comparisons.

Management Goal:

The Beechatuda Tongue Geological Formation will be managed to protect scientific study values.

Management Prescriptions:

1. Manage existing oil and gas leases under No Surface Occupancy constraint. Where this is not possible, coordinate with existing lease holder-operators on siting of development to minimize resource damage.
2. Discretionary closure on new oil and gas leasing.
3. Close to all other forms of mineral entry.
4. Acquire all non-federal minerals.
5. Acquire easement.
6. Land ownership not available for disposal.
7. Preclude new ROWs that would negatively affect protected resource or purpose.
8. Designate Closed OHV Area.
9. Implement VRM Class IV designation.
10. Continue current permitting for livestock grazing.



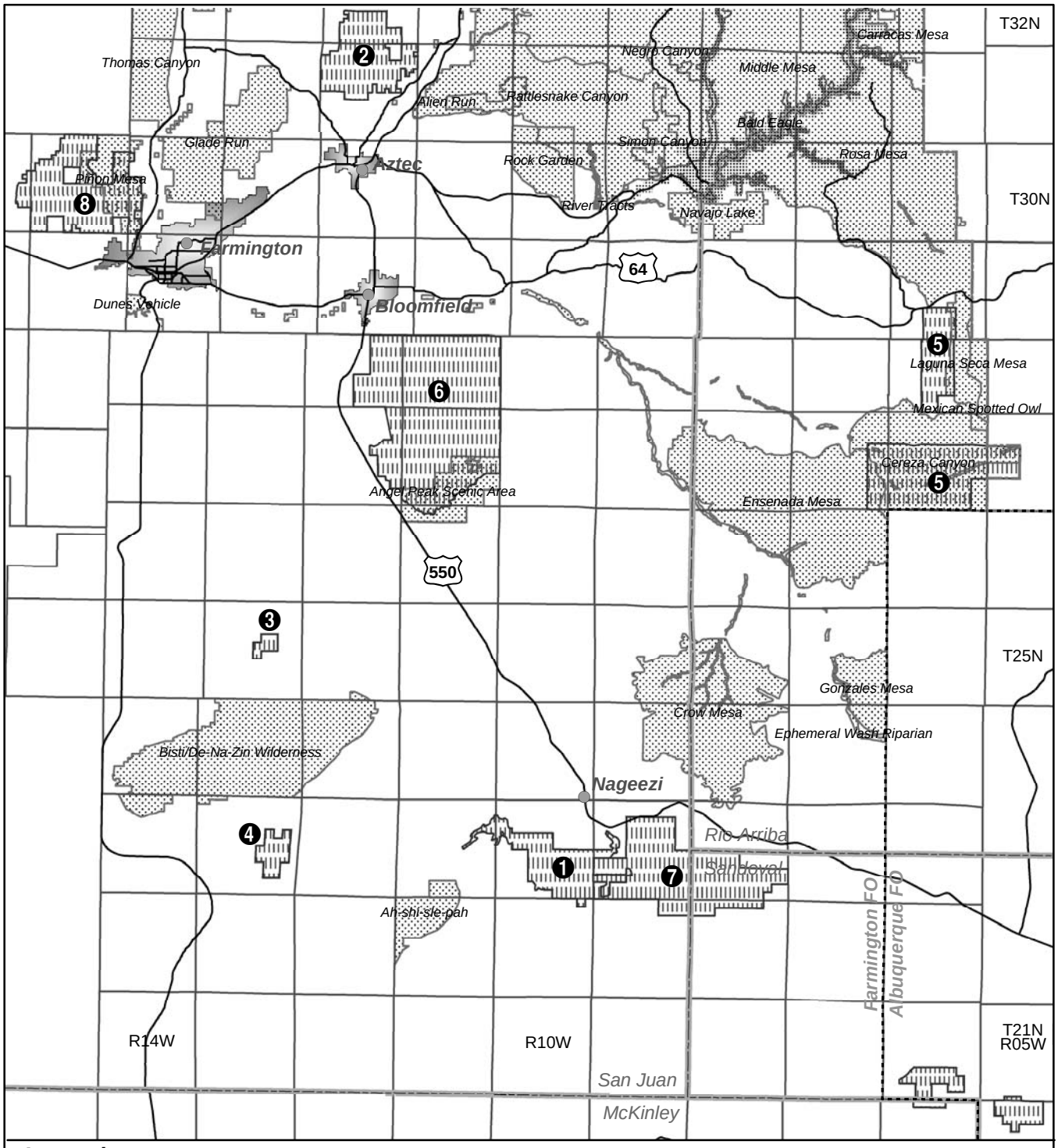
Map C-10: Beechatuda Tongue Geological Formation

3. PALEONTOLOGY

GENERAL DESCRIPTION

The San Juan Basin has been known to be an important area for mammalian and reptilian fossils since the late 1800s. A variety of paleontological resources exist in the planning area, including animal fossils, fossil leaves, palynomorphs, petrified wood, and trace fossils, occurring in the Triassic, Jurassic, Cretaceous, and Tertiary rocks. Dinosaur and other fossils that have made significant contributions to the scientific record have been found and excavated in the FFO area within the past 5 years. At least one of these, Betonnie Tsosie, is a type location for early Paleocene North American land mammals.

In order to preserve important paleontological resources for scientific study and other public benefits, the following eight Fossil Areas have been designated.



Legend

- County Boundary
- Field Office Boundary
- Major Road
- National Forest
- Township and Range
- SDA
- USBR
- Urban Area
- City or Town

- Paleontology Area
- ❶ Betonnie Tsosie
- ❷ Bohanon Canyon Fossil Complex
- ❸ Carson Fossil Pocket
- ❹ Fossil Forest
- ❺ Gobernador and Cereza Canyon Fossil Area
- ❻ Kutz Canyon Fossil Area
- ❼ Lybrook Fossil Area
- ❽ Pinon Mesa Fossil Area

N

4 2 0 4

Scale in Miles

Map C-11: Paleontology Areas

BETONNIE TSOSIE FOSSIL AREA

Site Description:

There are approximately 11,849 acres within the boundary of the Betonnie Tsosie Fossil Area, of which 7,267 acres are public land (BLM) and 7,267 acres contain federal minerals. The type locality for the early Paleocene (Puercan) North American land mammal "age" is located in the vicinity of Betonnie Tsosie Wash approximately 40 miles southeast of Farmington, N.M. The Puerco fauna is found in the lower part of the Nacimiento Formation, which forms badlands topography along the washes. The area is used for energy development (oil and gas wells) and grazing.

In 1874, E.D. Cope observed beds below the rocks he identified as Eocene in age at Cuba Mesa. He applied the name Puerco to them, although he didn't find fossils in them. In 1882, he decided that fossils being collected elsewhere for him by D. Baldwin were equivalent. Additional work on "Puerco" beds was conducted by H.F. Osborn, C. Earle, J.L. Wortman, W. Granger, and W.D. Matthew during subsequent years.

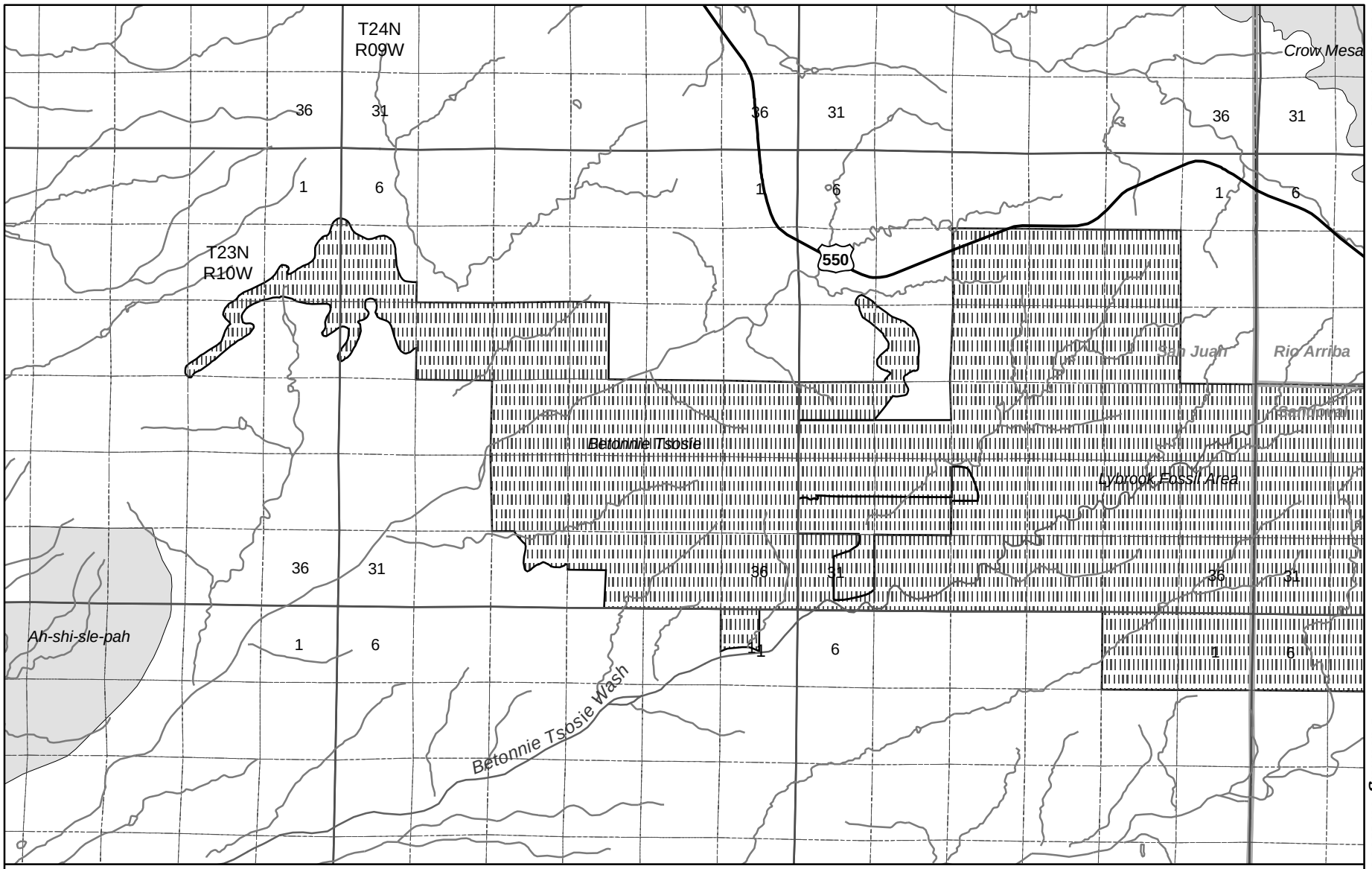
It was Matthew (1897) who divided the mammals from what was to be defined as the Paleocene Epoch into two distinct faunas: an older "Puerco" and a younger "Torrejon." Simpson (1981) in his review of the history of the San Juan Basin vertebrate paleontology noted that "Apparently it did not occur to anyone until much later that the Puerco of Cope has a type locality where no fossils had yet been found and which might prove to be equivalent to either 'Puerco' or 'Torrejon' of Matthew, or both, or neither." In 1937 Matthew's studies were posthumously published on the early Tertiary faunas of the San Juan Basin. In this manuscript he delineated the Puerco, Torrejon, and Tiffany faunas, which form the Paleocene Epoch such that the rest of the world adopted Matthew's usage. Simpson (1959) demonstrated that at least some of Cope's Puerco is actually Torrejonian in age. The Betonnie Tsosie group represents principal collecting localities for Matthew's Puerco fauna.

Management Goal:

The goal for special management of the Betonnie Tsosie Fossil Area is to facilitate scientific study and protection of the paleontological resources.

Management Prescriptions:

1. Manage existing oil and gas leases under Controlled Surface Use constraint.
2. Manage new oil and gas leases under Controlled Surface Use constraint
3. Paleontological clearance required on surface-disturbing activities on current and new oil and gas leased acreage.
4. The development of non-oil and gas leasables. salables, and locatables is permitted on a case-by-case basis with stipulations that protect paleontological values.
5. Acquire all non-federal minerals.
6. Acquire non-federal inholdings.
7. Land ownership not available for disposal.
8. ROWs granted on a case-by-case basis with management constraints that protect paleontological values.
9. OHV limited to maintained roads, designated routes, and trails.
10. Implement VRM Class III designation.
11. Woodcutting open to permitted gathering of dead and down.
12. Vegetation modification allowed on a case-by-case basis with paleontological clearance.
13. Continue current permitting for livestock grazing.
14. Develop Activity Plan.



Legend

- Major Road
- Township and Range
- Section Line
- County Boundary
- Drainage Channel
- SDA
- Paleontology

N

1 0.5 0 1

Scale in Miles

Map C-12: Betonnie Tsosie Fossil Area

BOHANON CANYON FOSSIL COMPLEX

Site Description:

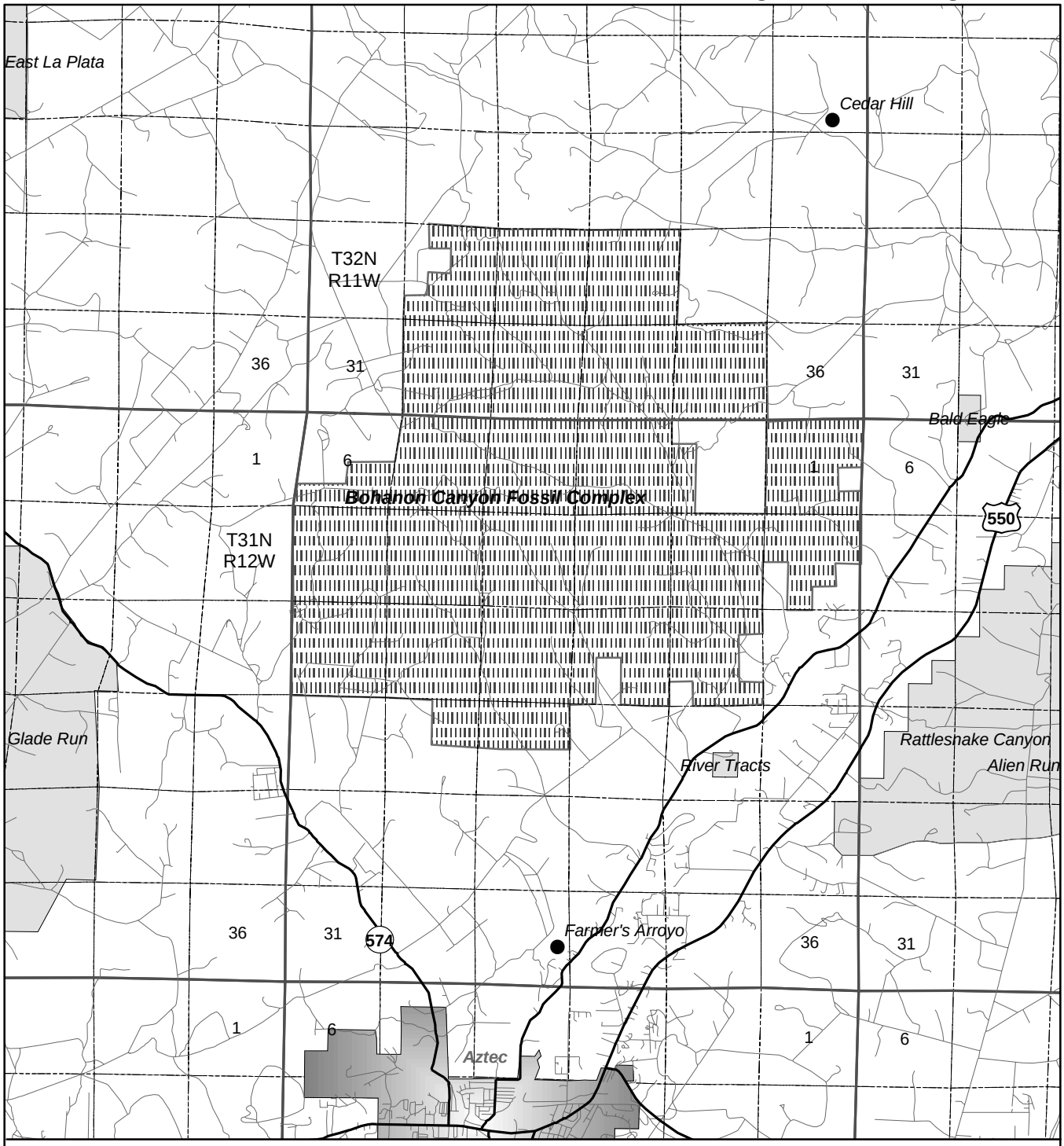
There are approximately 13,834 acres within the boundary of the Bohanon Canyon Fossil Complex, of which 12,380 acres are public land (BLM) and 12,468 acres contain federal minerals.

Management Goal:

The goal for special management is to facilitate scientific study and protection of the paleontological resources.

Management Prescriptions:

1. Manage existing oil and gas leases under Controlled Surface Use constraint.
2. Manage new oil and gas leases under Controlled Surface Use constraint.
3. Paleontological clearance required for surface-disturbing activities on current and new oil and gas leased acreage.
4. The development of non-oil and gas leasables. salables, and locatables is permitted on a case-by-case basis with stipulations that protect paleontological values.
5. Land ownership not available for disposal.
6. ROWs granted on a case-by-case basis with management constraints that protect paleontological values.
7. OHV limited to maintained roads, designated routes, and trails.
8. Implement VRM Class III designation.
9. Woodcutting open to permitted gathering of dead and down.
10. Vegetation modification allowed on a case-by-case basis with paleontological clearance.
11. Continue current permitting for livestock grazing.



Map C-13: Bohanon Canyon Fossil Complex

CARSON FOSSIL POCKET

Site Description:

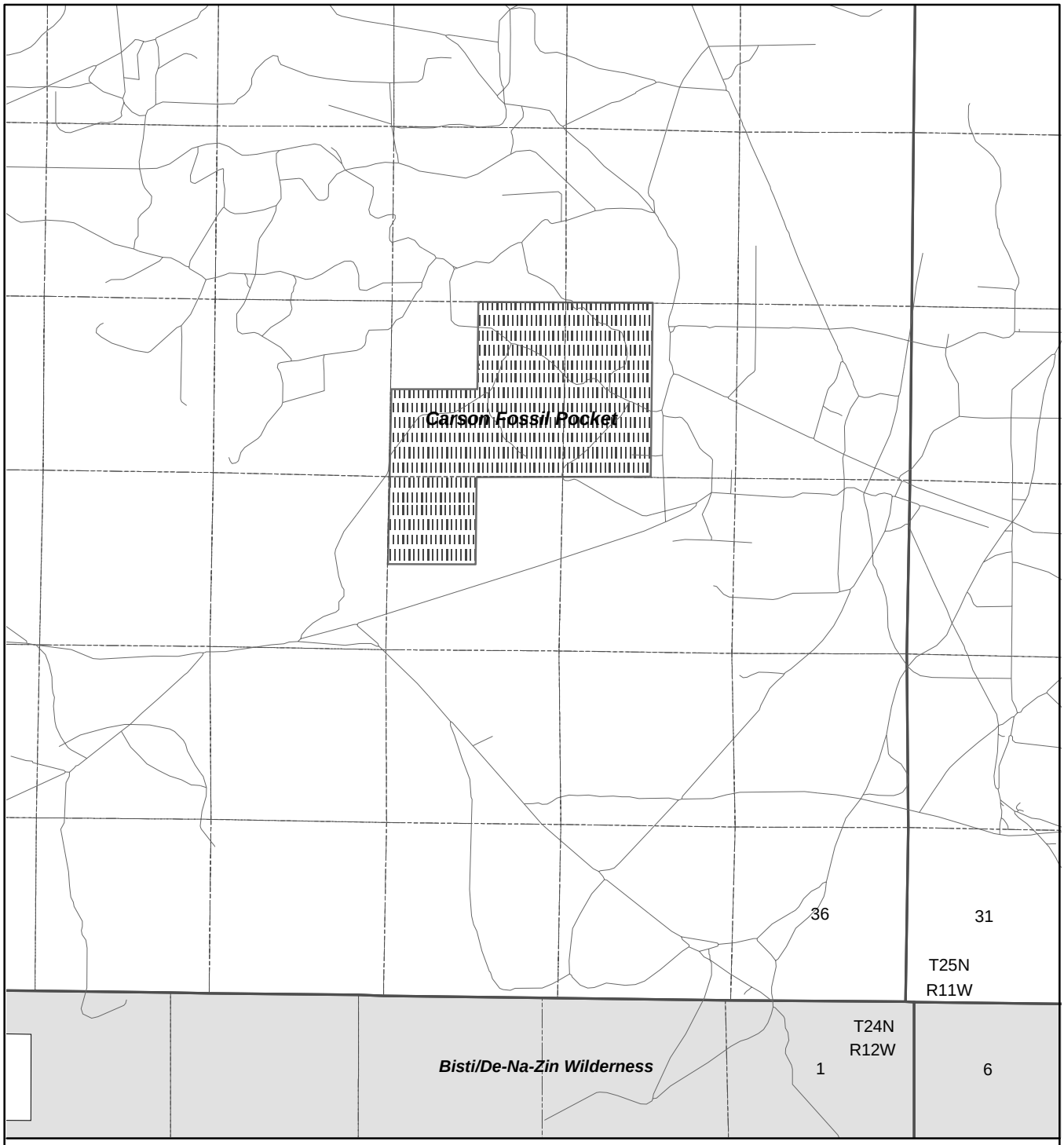
There are approximately 968 acres within the boundary of the Carson Fossil Pocket, all of which are public land (BLM) and all of which contain federal minerals.

Management Goal:

The goal for special management is to facilitate scientific study and protection of the fossils.

Management Prescriptions:

1. Manage existing oil and gas leases under Controlled Surface Use constraint.
2. Manage new oil and gas leases under Controlled Surface Use constraint.
3. Paleontological clearance required for surface-disturbing activities on current and new oil and gas leased acreage.
4. The development of non-oil and gas leasables. salables, and locatables is permitted on a case-by-case basis with stipulations that protect paleontological values.
5. Land ownership not available for disposal.
6. ROWs granted on a case-by-case basis with management constraints that protect paleontological values.
7. OHV limited to maintained roads, designated routes, and trails.
8. Implement VRM Class III designation.
9. Woodcutting open to permitted gathering of dead and down.
10. Vegetation modification allowed on a case-by-case basis with paleontological clearance.
11. Continue current permitting for livestock grazing.



Map C-14: Carson Fossil Pocket

FOSSIL FOREST RNA

Site Description:

There are approximately 2,796 acres within the boundary of the Fossil Forest RNA, all of which are public land (BLM) and all of which contain federal minerals. Fossil Forest Research Natural Area was designated under the Bisti/De-Na-Zin Wilderness Expansion and Fossil Forest Protection Act of 1996 for its natural, scientific, and educational values. The area derives its name from the over 400 petrified tree stumps found there, although its dinosaur and mammal fossils are of greater scientific value. Study of the fossils began in the early 1920s by Charles Sternberg, a professional collector, although some earlier work may have occurred. Although this area was known in science during the following decade, a paleontological survey (Kues et al. 1977) brought attention to its more significant fossils. Collection permits may be issued for research, museum, or educational projects.

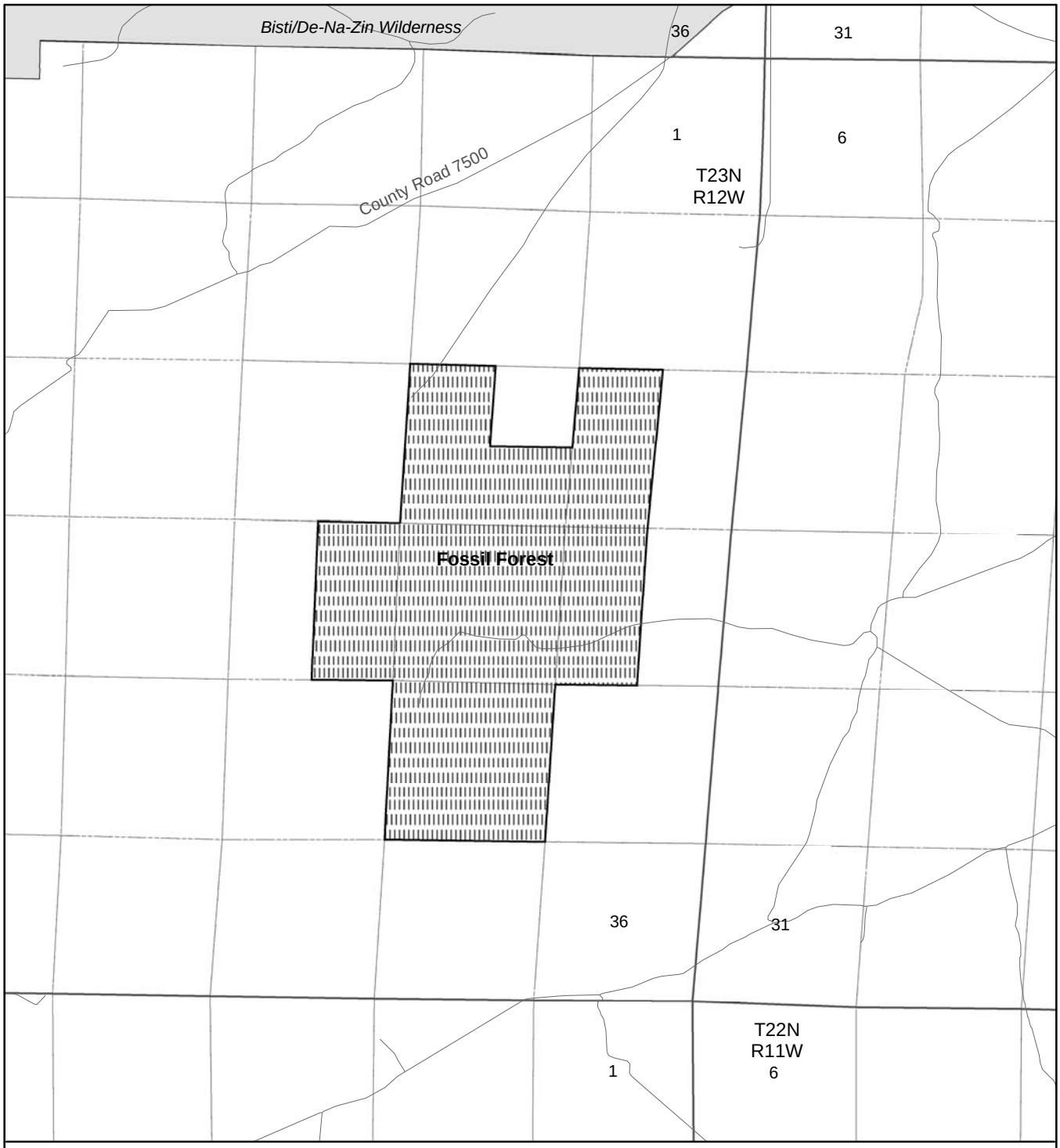
Fossil Forest is dominated by badlands topography where mudstone and sandstone of the Fruitland Formation and Kirtland Shale create low hills and gentle slopes. Stabilized aeolian sand covers the high flat areas, although there are small local areas with actively shifting sands.

Management Goal:

The management goal is to fulfill the requirement of the enabling legislation and to take measures when necessary to ensure that no activities disturb the land surface or impair the area's existing natural, educational, and scientific research values, including paleontological study, excavation, and interpretation.

Management Prescriptions:

1. Nondiscretionary closure on new oil and gas leasing.
2. Close to all other forms of mineral entry.
3. Land ownership not available for disposal. Acquire easement.
4. Preclude ROWs.
5. Closed to OHV use except for administrative and permitted use.
6. Implement VRM Class I designation.
7. Closed to woodcutting and gathering.
8. Closed to vegetation gathering and sale. Vegetative treatments must benefit cultural, scientific, and educational values. Paleontological clearance required.
9. Closed to livestock grazing.
10. Sign and fence portions of the boundary.
11. Identify as Noise Sensitive Area.
12. Prepare Management Plan.
13. Develop baseline inventory of fossil resources in the area.



Map C-15: Fossil Forest RNA

GOBERNADOR AND CEREZA CANYON FOSSIL AREA

Site Description:

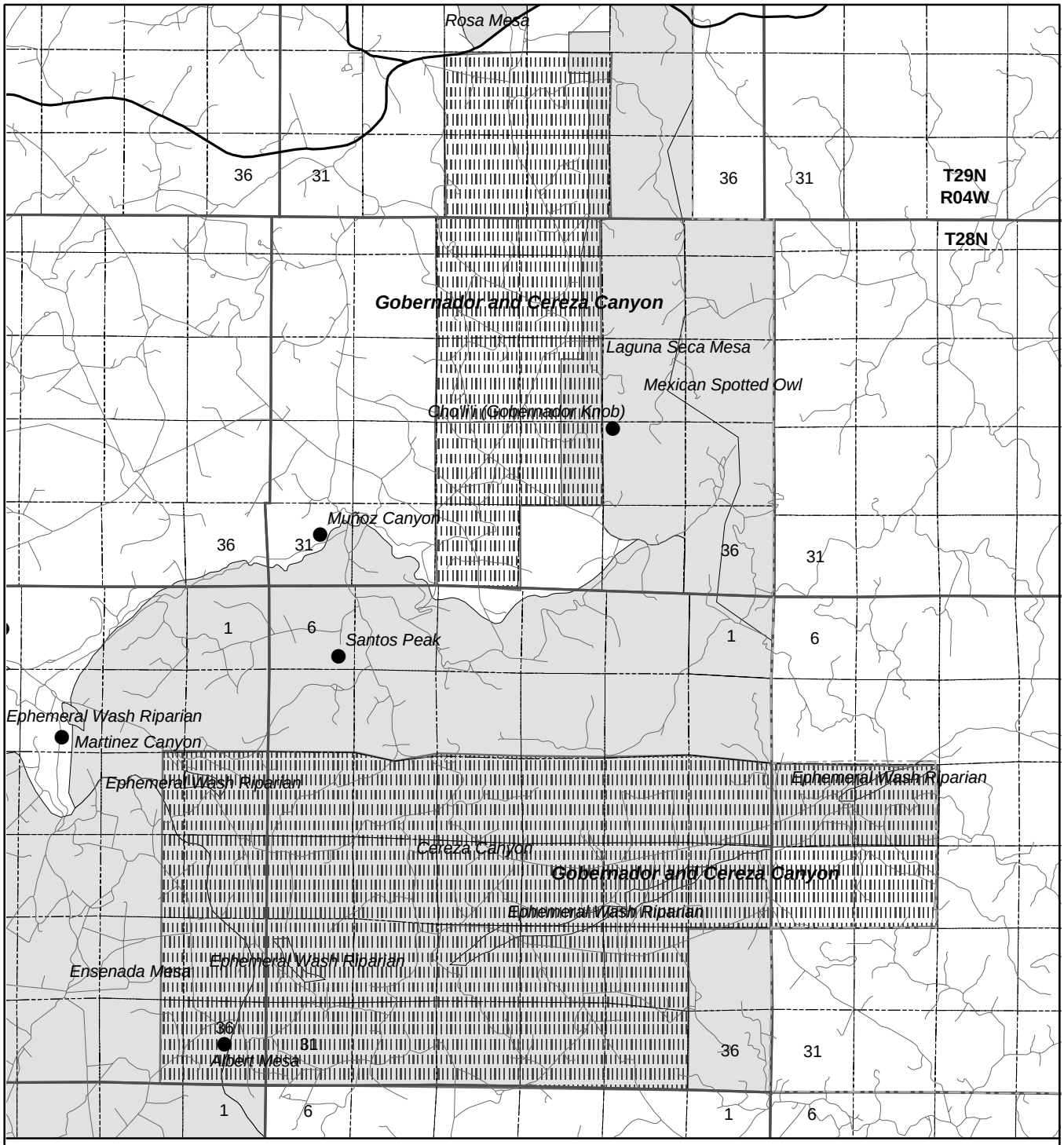
There are approximately 27,647 acres within the Gobernador and Cereza Canyon Fossil Area, of which 13,333 acres are public land (BLM) and 25,643 acres contain federal minerals.

Management Goal:

The goal for special management is to facilitate scientific study and protection of paleontological resources.

Management Prescriptions:

1. Manage existing oil and gas leases under Controlled Surface Use constraint.
2. Manage new oil and gas leases under Controlled Surface Use constraint.
3. Paleontological clearance required on surface-disturbing activities for current and new oil and gas leased acreage.
4. The development of non-oil and gas leasables. salables, and locatables is permitted on a case-by-case basis with stipulations that protect paleontological values.
5. Acquire easements.
6. Land ownership not available for disposal.
7. ROWs granted on a case-by-case basis with management constraints that protect paleontological values.
8. OHV limited to maintained roads, designated routes, and trails.
9. Implement VRM Class IV designation.
10. Woodcutting open to permitted gathering of dead and down.
11. Vegetation modification allowed on a case-by-case basis with paleontological clearance.
12. Continue current permitting for livestock grazing.



Legend

- Carson NF
- Township and Range
- Road
- Section Line
- Cultural SDA
- SDA
- Paleontology

N

0.8 0.4 0 0.8

Scale in Miles

Map C-16: Gobernador and Cereza Canyon Fossil Area

KUTZ CANYON FOSSIL AREA

Site Description:

There are approximately 48,423 acres within the boundary of the Kutz Canyon Fossil Area, of which 47,098 acres are public land (BLM) and 47,661 acres contain federal minerals. Kutz Canyon, an area of badlands and canyon topography, lies southeast of Bloomfield, NM.

The first published account of fossils here was by Granger (1917) after his American Museum of Natural History expedition in 1916. Subsequent work by other researchers, notably Wilson during the 1940s and '50s, doubled the known taxa. Research continues through the present.

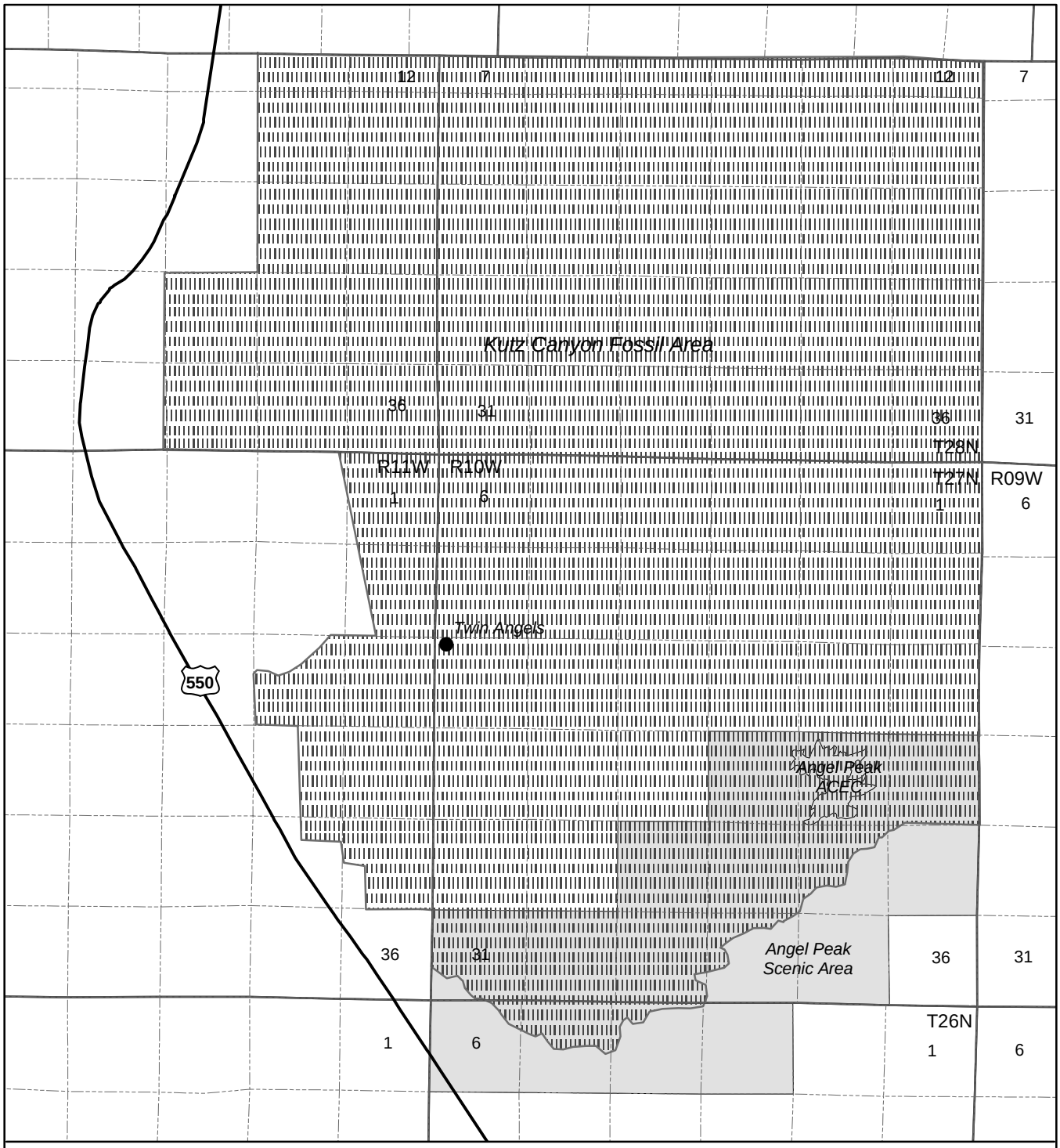
Fossils are found in the badlands exposures of the Paleocene Nacimiento Formation. Turtle, lizard, and crocodilian fossils are typical of reptilian specimens. The mammalian fossils are the most significant, since they are critical to the description of what historically has been termed the *Deltatherium* 'zone' of the Torrejonian land mammal age. Lucas and O'Neill (1981) reported the first occurrence of *Pantolambda* in the *Deltatherium* 'zone'. Previously thought to be restricted in the *Pantolambda* 'zone', this finding cast doubt on the whole notion of Torrejonian 'zones'. Kutz Canyon therefore demonstrates the dynamic nature of paleontology and the significance of continued investigation of classic collecting localities.

Management Goal:

The specific management goal is the protection of paleontological resources for scientific study.

Management Prescriptions:

1. Manage existing oil and gas leases under Controlled Surface Use constraint.
2. Manage new oil and gas leases under Controlled Surface Use constraint.
3. Paleontological clearance required for surface-disturbing activities on current and new oil and gas leased acreage.
4. The development of non-oil and gas leasables. salables, and locatables is permitted on a case-by-case basis with stipulations that protect paleontological values.
5. Land ownership not available for disposal.
6. ROWs granted on a case-by-case basis with management constraints that protect paleontological values.
7. OHV limited to maintained roads, designated routes, and trails.
8. Implement VRM Class II, III, and IV designation.
9. Woodcutting open to permitted gathering of dead and down.
10. Vegetation modification allowed on a case-by-case basis with paleontological clearance.
11. Continue current permitting for livestock grazing.



Map C-17: Kutz Canyon Fossil Area

LYBROOK FOSSIL AREA

Site Description:

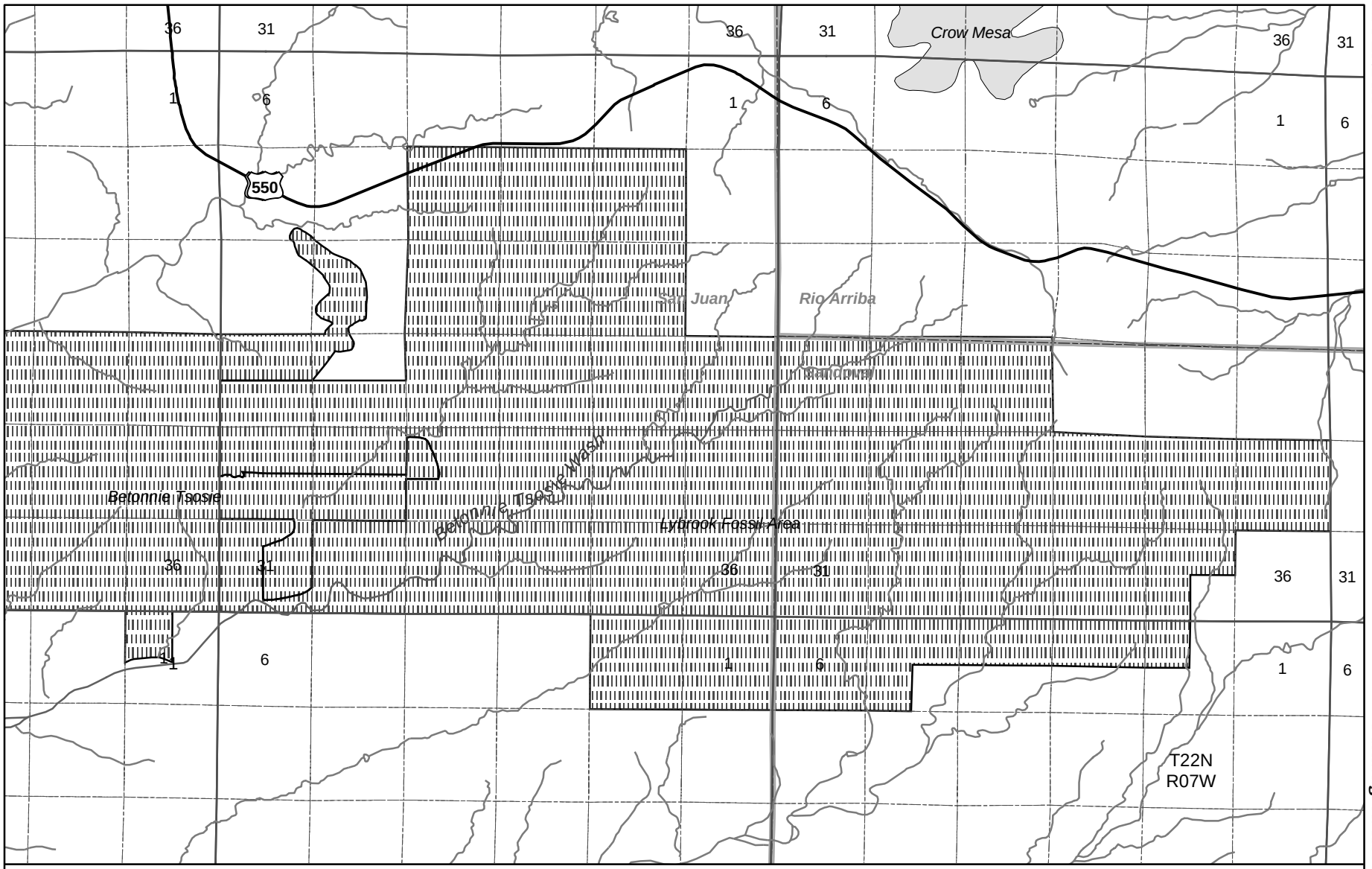
There are approximately 25,703 acres within the boundary of the Lybrook Fossil Area, of which 18,268 acres are public land (BLM) and 19,840 acres contain federal minerals.

Management Goal:

The goal for special management is to facilitate scientific study and protection of the paleontological resources.

Management Prescriptions:

1. Manage existing oil and gas leases under Controlled Surface Use constraint.
2. Manage new oil and gas leases under Controlled Surface Use constraint.
3. Paleontological clearance required for surface-disturbing activities on current and new oil and gas leased acreage.
4. The development of non-oil and gas leasables. salables, and locatables is permitted on a case-by-case basis with stipulations that protect paleontological values.
5. Land ownership not available for disposal.
6. ROWs granted on a case-by-case basis with management constraints that protect paleontological values.
7. OHV limited to maintained roads, designated routes, and trails.
8. Implement VRM Class III and IV designation.
9. Woodcutting open to permitted gathering of dead and down.
10. Vegetation modification allowed on a case-by-case basis with paleontological clearance.
11. Continue current permitting for livestock grazing.



Legend

- Major Road
- Township and Range
- Section Line
- County Boundary
- SDA
- Paleontology

Map C-18: Lybrook Fossil Area

PIÑON MESA FOSSIL AREA

Site Description:

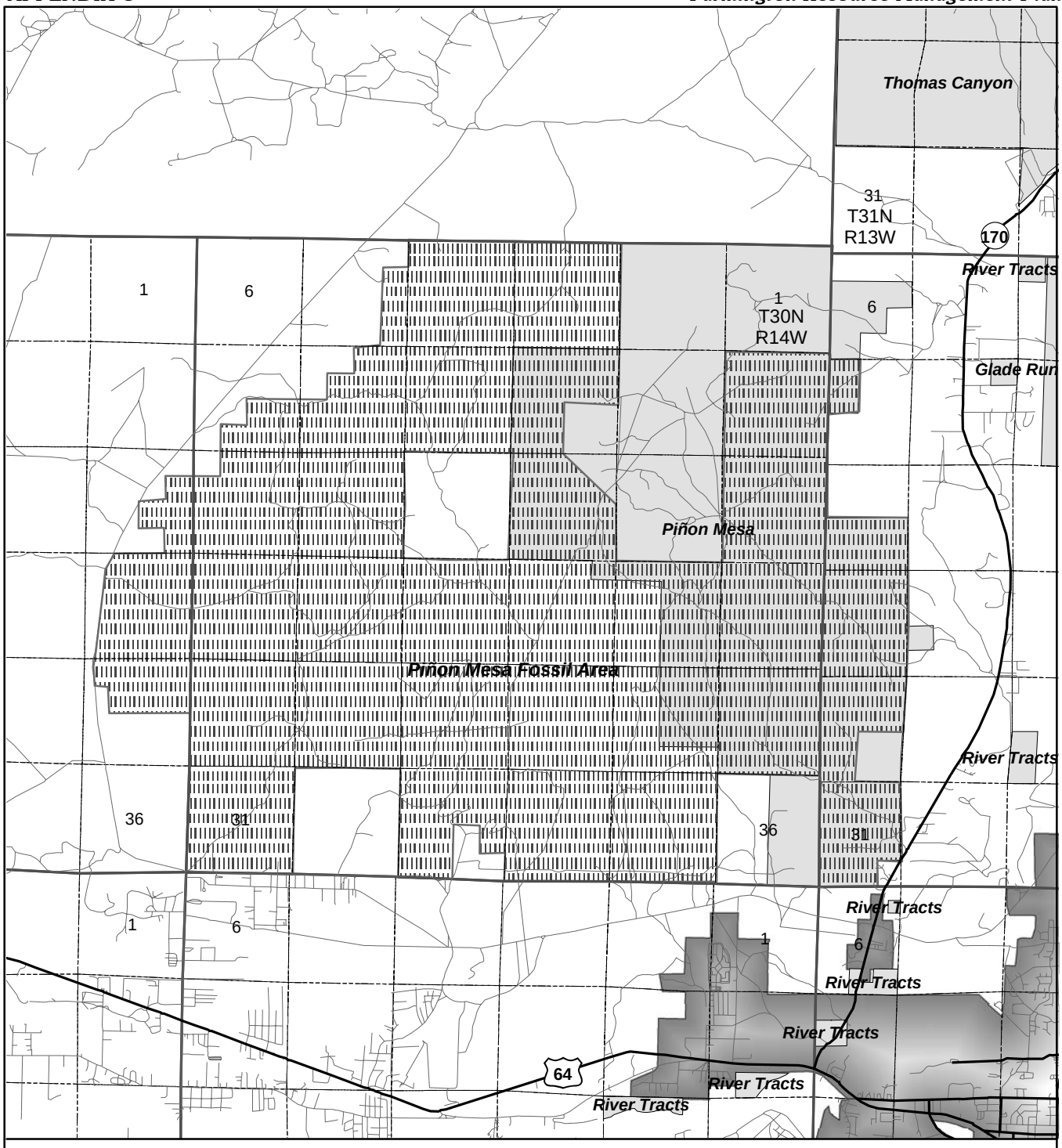
There are approximately 19,052 acres within the boundary of the Piñon Mesa Fossil Area, of which 18,197 acres are public land (BLM) and 19,033 acres contain federal minerals. The Piñon Mesa Fossil Area overlaps part of the Piñon Mesa Recreation Area. Where boundaries overlap, management prescriptions for the Piñon Mesa Recreation Area will apply and will include measures necessary for protection of paleontological resources.

Management Goal:

The goal for special management is to facilitate scientific study and protection of the paleontological resources.

Management Prescriptions:

1. Manage existing oil and gas leases under Controlled Surface Use constraint. Paleontological clearance is required for actions on existing leases.
2. Manage new oil and gas leases under Controlled Surface Use constraint. Paleontological clearance is required for actions on new leases.
3. Close to all forms of mineral entry where Piñon Mesa Fossil Area overlaps the Piñon Mesa Recreation Area, except for the development of underground coal mining in T. 30 N., R. 14 W., Section 22 NE¼NE¼, Section 23 E½ and N½NW¼, and Section 26 NE¼ and N½SE¼. These parcels will be available for underground coal mining with stipulations to ensure that the trail corridors will remain open to public access and paleontological resources are protected. Paleontological surveys prior to underground mining and periodic monitoring to check on subsidence during mining may be required.
4. The development of leasables, salables, and locatables is permitted on acreage outside the Piñon Mesa Recreation Area on a case-by-case basis with the stipulations listed in Item 3 above.
5. Acquire easements.
6. Land ownership not available for disposal.
7. ROWs granted on a case-by-case basis with management constraints that protect paleontological values.
8. OHV limited to maintained roads, designated routes, and trails.
9. Implement Class III VRM designation.
10. Woodcutting open to permitted gathering of dead and down.
11. Vegetation modification allowed on a case-by-case basis with paleontological clearance.
12. Continue current permitting for livestock grazing.



Map C-19: Piñon Mesa Fossil Area